



April 19, 2017

Project No. 16098-01

To: Toll Brothers, Inc.
725 Town & Country Road, Suite 200
Orange, California 92868

Attention: Mr. Peter H. Kim

Subject: Geotechnical Evaluation of Proposed Residential and School Site Development,
Nakase Property, Lake Forest, California

INTRODUCTION

In accordance with your request, NMG Geotechnical, Inc. (NMG) has conducted a feasibility level study for the residential and school site development planned at the subject site. The site is approximately 120 acres and is located south of the intersection of Bake and Rancho Parkways in the city of Lake Forest (Figure 1). A 100-scale mass grading plan prepared by Hunsaker Associates was provided for our review and utilized as a base plan for our geotechnical map (Plate 1). The purpose of our geotechnical study was to evaluate the proposed residential and school site development in light of the existing geologic conditions and provide mitigation recommendations for the geotechnical constraints. Our work is based on the topographic map and mass grading plan prepared by Hunsaker Associates; our background research; site reconnaissance; subsurface exploration; limited laboratory testing; evaluation of the compiled data; and meetings/conversations with Toll Brothers and the project team.

ATTACHMENTS

Figure 1 – Site Location Map – Rear of Text
Figure 2 – Seismic Hazards Map – Rear of Text
Appendix A – References
Appendix B – Geotechnical Boring and CPT Logs
Appendix C – Laboratory Test Results
Plate 1 – Geotechnical Map – In Pocket

SCOPE OF SERVICES

Our scope of services included the following:

- Acquisition and review of available published geologic maps and data pertinent to the subject site. The list of references utilized is included in Appendix A.
- Review of historic stereographic aerial photographs relevant to the site. The list of photographs reviewed is included in Appendix A.
- Drilling, sampling and logging of six hollow-stem auger borings (B-1 through B-6) to depths of 51.5 to 55 feet below ground surface (bgs). Thirteen CPT soundings (CPT-1 through CPT-13) were also advanced to depths of up to 50 feet bgs. The approximate location of our borings and CPTs is provided on the Geotechnical Map (Plate 1). Boring and CPT logs are included in Appendix B. Notification and coordination with Underground Service Alert to identify and locate any underground utilities was also performed prior to subsurface exploration.
- Limited Laboratory testing of selected samples to determine in-situ moisture and density and evaluate consolidation potential. The test results are provided in Appendix C.
- Review of the mass grading plan.
- Compilation and evaluation of the collected geotechnical data with respect to the anticipated improvements and evaluation of preliminary mitigation measures.
- Preparation of this report, including our findings, discussion of geotechnical issues, conclusions, and recommendations for the planned development.

SITE LOCATION AND EXISTING CONDITIONS

The proposed residential and school site development is located on an approximate 120-acre parcel in the city of Lake Forest bounded by Bake Parkway on the northwest, Rancho Parkway on the northeast, Serrano Creek on the southeast and existing commercial property on the southwest.

The site consists of relatively gentle terrain ranging in elevations from 705 to 735 feet across the northern half of the site with low points of approximately 685 feet at the southwest and southeast corners and a ridge in the south central ranging from 720 to 750 feet. Rancho Parkway is roughly 10 feet above the northern perimeter; Bake Parkway 5 to 10 feet above the western perimeter; the commercial development 10 feet above to 25 feet below the southern perimeter and Serrano Creek is 5 to 10 feet (locally up to 17 feet) below the eastern perimeter. There is a central drainage ditch that extends from the northern boundary (collecting water from a storm- drain pipe adjacent to Rancho parkway) across the site to a low point where it empties into a storm drain pipe at the southern boundary. Currently, the site is an operating plant nursery consisting of extensive rows of container plants which are periodically rotated. Some areas are covered by netting providing partial shade. There is an area of stockpiled soil and onsite borrow cutting. Trailer trucks and a plant loading area are located northwest of the ridge. An extensive sprinkler system exists throughout the site and the ground surface drains generally towards the central drainage ditch and locally towards Serrano Creek.

PREVIOUS GRADING

The property was graded to its current condition before the Nakase family purchased the nursery site in the late 1970s. Based on comparison of the 1949 USGS topographic map for this area to the current topography recently obtained by Hunsaker, the site has been raised substantially along Serrano Creek (5 to 15 feet) and adjacent to Rancho Parkway (4 to 10 feet). It appears that the undocumented fill was removed from the site along Bake Parkway at the northwest portion of the site (minus 3 to 8 feet) and from the northern flank of the bedrock ridge (minus 5 to 12 feet) and placed in the northern half to flatten out the topography. We estimate that approximately 200,000 yards of fill has been placed to create the site conditions. We assume remedial grading was not performed for this work and the undocumented fill is underlain by unsuitable alluvium. The undocumented fill was encountered in our recent borings and CPTs (Appendix B).

Prior grading was performed for the segments of Bake Parkway and Rancho Parkway adjacent to the subject site. Along Rancho Parkway up to approximately 25 feet of fill was placed over alluvium in the two primary canyons and minor cut in the middle ridge was performed to create the road grades. Along Bake Parkway, grading consisted primarily of cuts into the hillside and fills up to 15 feet thick in the side canyon areas. We understand Bake Parkway was graded by the AJ West development (circa 1992) and Rancho Parkway was graded by the Home Depot commercial center development (circa 2001).

PROPOSED GRADING

Based on review of the mass grading plan by Hunsaker the rough finish grade surface will range from an elevation of 700 feet at the southwest corner to 727 feet at the northeast corner. Cut and fill grading will be required to achieve this condition. Both ascending and descending slopes are shown around the perimeter of the site ranging from 0 to 26 feet high.

SUBSURFACE EXPLORATION

Geotechnical exploration was performed by NMG across the site for this study. The exploration consisted of drilling, sampling and logging of six hollow-stem auger borings (B-1 through B-6) to depths ranging from 50 to 55 feet below existing grades. Thirteen CPT soundings (CPT-1 through CPT-13) were also advanced to depths of up to 50 feet. The approximate location of our borings and CPTs is provided on the Geotechnical Map (Plate 1) and boring and CPT logs are included in Appendix B

Relatively undisturbed soil ring samples were obtained from NMG's exploratory Borings with a 2.5-inch-inside-diameter, split-barrel sampler. The drive samples were also used to obtain a measure of resistance of the soil to penetration (recorded as blows-per-foot on our geotechnical boring logs). Within hollow-stem borings, samplers were driven with a 140-pound hammer, free-falling 30 inches. Bulk samples of onsite soil were collected from the hollow-stem cuttings and used for additional soil identification purposes and laboratory testing. Soil samples were visually classified in accordance with the Unified Soil Classification System (USCS).

LABORATORY TESTING

For this study, limited laboratory testing was performed on representative samples of onsite soils collected to characterize basic soil engineering properties of the alluvium. Laboratory tests on selected relatively undisturbed and bulk soil samples included:

- Moisture content and dry density
- Consolidation

Laboratory tests were conducted in general conformance with applicable American Society for Testing and Materials (ASTM) standard test methods. Laboratory test results are provided in Appendix C. In-situ moisture content and dry density data are included on the geotechnical boring logs (Appendix B).

Geologic Conditions

The majority of the site is underlain by deep quaternary alluvium deposited in three distinct canyons trending roughly northeast across the site. The central canyon and Serrano Creek merge together at the site and the canyon parallel to Bake Parkway extends through the site. Undocumented fill covers the alluvium in the northern half of the site and along Serrano Creek. Sandstone of the Capistrano Formation is exposed in the ridge in the south-central portion of the site and in limited exposures along Bake Parkway and Rancho Parkway. Bedding generally dips at low angles (8-19 degrees) northeast to northwest. Slope wash deposits are mapped on the lower flanks of the natural slopes immediately adjacent to the bedrock exposures. The geologic conditions are depicted on Plate 1 (in pocket).

Groundwater

Groundwater is present within the alluvium beneath the site. The groundwater encountered in our recent borings and CPTs ranged from 20 to 40 feet deep. Based on maps published by the State of California, the historic high groundwater levels at the site ranged from 15 to 20 feet deep. Currently, there is a water-well located in the southwest corner of the site that provides irrigation water for the nursey operation.

Surface Water

Currently, Serrano Creek is essentially dry except for the southeast corner of the site where runoff from the nursery flows into the creek via small-diameter drain pipes. The primary surface flow coming into the site is from a storm drain pipe under Rancho Parkway. This surface water flows through the site in an open ditch and exits the site at the southwest end into a storm drain inlet.

DISCUSSION OF GEOTECHNICAL ISSUES

The following is a discussion of the geotechnical issues pertinent to the development planned at the subject site. It is important to note that, at this time, finish grades for the development are

uncertain which may have a significant impact on many of the geotechnical issues. These issues are summarized below:

1) Undocumented Fill: The property was graded before the Nakase family purchased the nursery site circa 1977. Based on comparison of the 1949 USGS topographic map to the current topography, the site has been raised substantially along Serrano Creek (5 to 15 feet) and adjacent to Rancho Parkway (4 to 10 feet). It appears that the undocumented fill was removed from the site along Bake Parkway at the northwest portion of the site where grades were lowered 3 to 8 feet and from the northern flank of the bedrock ridge which was cut down 5 to 12 feet. The undocumented fill was encountered in the borings and CPTs and appears to be placed directly over native alluvium. The undocumented fill should be removed during remedial grading.

2) Alluvium: Quaternary alluvium is exposed throughout the majority of the site in the old canyon areas (CDMG, 1974). The borings and CPTs were excavated/advanced to a depth of 50 feet and generally exposed alluvium to the total depths. The alluvium consisted of silty to clayey sands with occasional layers of gravel and beds of silt and clay. Based on the collected data and experience on adjacent properties, the alluvium is most likely up to 70 to 80 feet thick in the deepest part of the old canyons. The alluvium is subject to an average remedial removal of 12 feet deep across the site and up to 15 feet deep in the old blue-line streams. Additional subsurface exploration is planned to further evaluate this earth unit once a more final grading plan is available for review.

3) Slope Wash: Slope wash is exposed on the lower flanks of the main bedrock ridge and the tips of the ridges exposed along Bake and Rancho Parkways (CDMG, 1974). This material is similar to colluvium and removals on the order of 10 feet deep are anticipated during remedial grading. Some subsurface exploration is planned to evaluate this earth unit.

4) Sandstone of Capistrano Formation: Sandstone bedrock will be exposed at finish grade in the central ridge area and locally along Bake and Rancho Parkways (CDMG, 1974). The sandstone is expected to be rippable with standard heavy equipment during grading. The density of the sandstone typically increases with depth and there are occasional layers of cemented sandstone. Residential lots founded in sandstone are planned to be over-excavated and capped with a minimum 5 feet of compacted fill. The deepest underground utility in these areas should be evaluated for rippability based on the typical trenching equipment to be utilized. Some subsurface exploration is planned to further evaluate this earth unit.

5) Faulting and Seismicity: There are no active faults within or immediately adjacent to the site based on review of the reports and maps published by the California Geologic Survey (CDMG, 2007). The closest active fault is the San Joaquin Hills Blind Thrust Fault, located 3.9 miles southwest of the site. This is the controlling fault for seismic design for this site and has a maximum moment magnitude estimated at 7.0 M_w (USGS, 2013a) and an estimated pga of 0.53g horizontal (USGS, 2013b).

The primary seismic hazard for this site is ground shaking due to a future earthquake on one of the major regional active faults, such as the San Joaquin Hills Blind Thrust, Whittier-Elsinore, Newport-Inglewood, San Jacinto and San Andreas Faults.

The site is located within an area of potential liquefaction (Figure 2), as defined by the State's Seismic Hazard Mapping Act (CDMG, 2001). Liquefaction is discussed in section 12. Secondary seismic hazards, such as tsunami or seiche, are considered slight to nil, as the site is located away from the ocean or confined bodies of water and at elevations well above (700 +/-feet) mean sea level.

6) Groundwater: Groundwater is present within the alluvium beneath the site. The groundwater encountered in our recent borings and CPTs ranged from 20 to 40 feet deep. These depths were measured during a time of extended drought conditions. Based on maps published by the State of California, the historic high groundwater levels at the site ranged from 15 to 20 feet deep (CDMG, 2000).

7) Serrano Creek Edge: The southeastern edge of the property is bounded by Serrano Creek. This boundary is approximately 2,600 feet long. The creek ranges from 10 to 14 feet deep for most of the length and 6 to 7 feet deep for the most southerly 500 feet near the entrance to the site. We understand that Serrano Creek is to remain in its natural state and there is an existing environmental setback line on both sides of the creek as previously documented by Glenn Lukos Associates. Due to the effects of liquefaction potential in the alluvium during a significant seismic shaking event, the exposed slope associated with Serrano Creek is subject to lateral slope failure. We have initially explored this condition with CPTs, advanced to 50 feet deep, in selected areas along this perimeter. Based on our initial analysis, a seismic shear key is needed to mitigate this condition. The top of the front cut for this key will start at the environmental setback boundary and the key will extend along the Serrano Creek edge. The actual dimensions of the key will be dependent on additional subsurface exploration and site specific analysis once the planned grades are established.

8) Storm Drain from Rancho Parkway: The storm drain pipe beneath Rancho Parkway is planned to be extended through the project by a storm drain pipe of similar capacity and connected to the storm drain inlet at the southwest end of the property. Subsequent to remedial grading the proposed storm drain pipe is anticipated to be underlain by compacted fill over alluvium.

9) Possible Open Channel: An open shallow channel or swale is planned from the northeast end of the site to the southwest corner where it will connect to a drainage basin. Although this channel will be underlain by compacted fill over alluvium the actual design will be important from a geotechnical standpoint. Specifically, the depth of the channel, adjacent slopes and horizontal distance from the adjacent structures will need to be evaluated.

10) Slope Stability along the Bake and Rancho Parkway Edges: There are two different issues along the Bake and Rancho Parkway edges. Both require detailed information of the graded conditions beneath the roads (e.g. fill thickness, any topsoil/colluvium left in place, any subdrains installed, etc.). If the project grade is raised to match the adjacent road grade, then it is important to rely on sound geotechnical conditions (e.g. fill over bedrock, fill over competent alluvium, etc.). If there is any soft soil or poor quality fill left in place, it would be subject to removal during remedial grading. If some of this material cannot be removed in order to prevent undermining the existing road, then a structural setback would be required to protect the planned structures from excessive differential settlement induced by the new fill loading.

If the project grades are below Bake and Rancho Parkways and the existing slopes are to essentially remain in place, then the stability of the slopes should be evaluated to ensure they have been graded to a standard that resulted in a 1.5 safety factor for gross and surficial stability. If there are any deficiencies with the existing slope then they would have to be regraded to project standards or a structural setback established to protect the planned structures.

Regardless of which option is selected, some subsurface exploration is planned to further evaluate these edge conditions. At this time, we understand that no geotechnical work can be performed until access is gained to that area of the project site.

11) Settlement: Fill placement planned for the site will induce minor settlement of the underlying alluvium. In order to limit the total and differential post-grading settlements within tolerable limits, partial removal of alluvium and settlement monitoring will need to be performed. To mitigate differential settlement in the design cut/fill transition areas over-excavation should be performed to mitigate this condition.

12) Liquefaction: Due to the site conditions of some of the layers within the granular alluvium and relatively shallow groundwater over most of the site, there is a potential for liquefaction to occur during a future major earthquake impacting the site. The anticipated remedial grading and compacted fill placement is anticipated to reduce the potential for surface manifestations. However, there may be the potential for a minor amount of seismic settlement to occur during a liquefaction event. This minor amount of liquefaction-induced settlement is anticipated to be mitigated by the foundation design for the planned structures.

13) Foundation Design: The onsite soils are generally granular in nature and are expected to have low expansion potential and be corrosive to metals. Post-tensioned slabs are anticipated for the proposed residential structures. Soil samples will be collected during our ongoing investigation, and laboratory testing will be performed to determine the preliminary parameters for foundation design. Imported fill should have similar soil engineering characteristics. If the imported fill has a higher expansion then the foundation design would need to be adjusted accordingly.

14) Scour Mitigation: We understand that the project will be required to provide scour protection related to periodic surface flow in Serrano Creek. Hunsaker will provide the scour depth needed and we will assist in design of the mitigation measures. We will help support the mitigation option when the selection is made. Laboratory testing and analysis will be required for any option considered.

15) Flood Control Issues: Hunsaker will be evaluating the stream flow within Serrano Creek and surface flows from the project site. They will be coordinating with the Orange County Flood Control District and other agencies as it relates to the proposed project. NMG will provide geotechnical support as needed for this work.

16) Water Quality Basin(s): A water quality basin is planned at the southwest end of the project. Other infiltration features may be planned within the site. Each of the locations considered for infiltration will need to have percolation testing performed and the data provided to the designer of the infiltration features.

17) School Site: A school site is planned to be incorporated within this development. It is our experience that it is best to grade the school site with onsite earth materials only. If imported fill is placed in the school site, then environmental testing of each import source will be required in accordance with DTSC requirements. Also, the school site needs to be investigated/designed in accordance with the requirements of DSA and CGS Note 48.

CONCLUSIONS AND RECOMMENDATIONS

We conclude the site is feasible for the planned residential and school site developments provided the geotechnical constraints impacting the site are mitigated to the standard of practice and the governing agency requirements. Specific recommendations are highlighted below:

1. Geotechnical investigation and grading reports for Bake and Rancho Parkways pertinent to the subject site should be acquired.
2. The geotechnical constraints should be taken into consideration as site development plan options are developed.
3. Additional subsurface exploration, laboratory testing, and analyses should be performed once more final development and grading plans are available.

LIMITATIONS

This report has been prepared for the exclusive use of our client, Toll Brothers Inc., within the specific scope of services requested by our client for the geotechnical evaluation of the subject residential and school site development. This report or its contents should not be used or relied upon for other projects or purposes or by other parties without the written consent of NMG. Our methodology for this study is based on local geotechnical standards of practice, care, and requirements of governing agencies. No warranty or guarantee, express or implied is given.

The findings, conclusions, and recommendations are professional opinions based on interpretations and inferences made from geologic and engineering data from specific locations and depths, observed or collected at a given time. By nature, geologic conditions can be very different in between points, and can also change over time. Our conclusions and recommendations are subject to verification and/or modification with more exploration and/or during grading and construction when more subsurface conditions are exposed.

If you have any questions regarding this report, please contact our office. We appreciate the opportunity to provide our services.

Respectfully submitted,

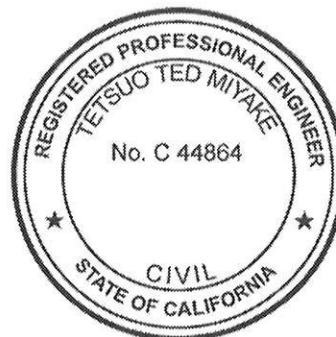
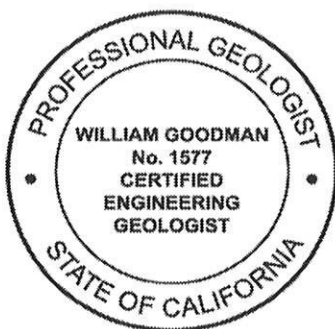
NMG GEOTECHNICAL, INC.

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(1) Mr. Fred Graylee, Hunsaker and Associates (E-Mail)



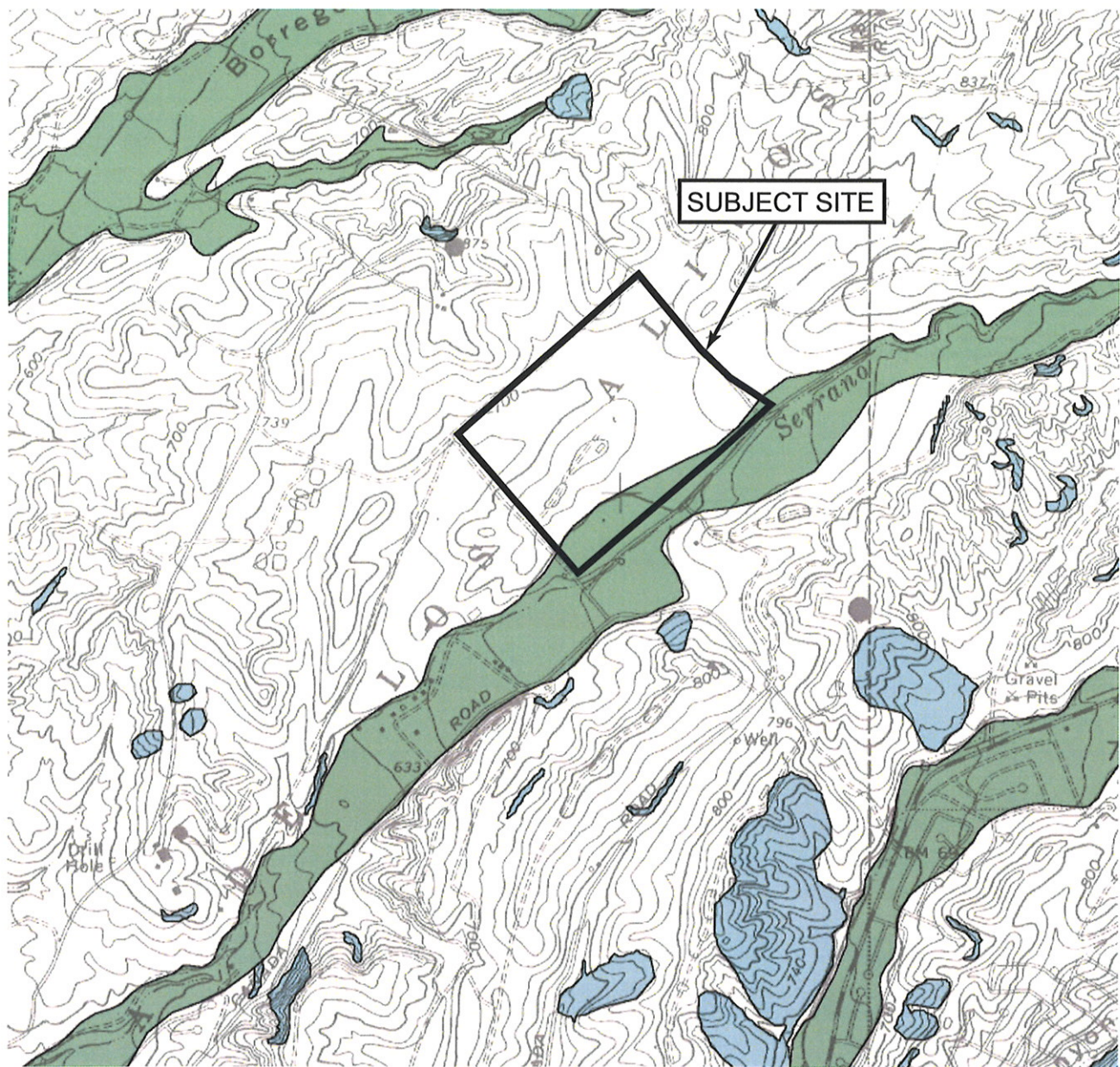
APPENDIX A

REFERENCES

- California Division of Mines and Geology, 2000, Seismic Hazard Zone Report for the El Toro 7.5-Minute Quadrangle, Orange County, California, SHZR 047.
- California Division of Mines and Geology, 2001, Seismic Hazard Zones Map for the El Toro Quadrangle, Official Map, Released January 17, 2001.
- Fife, D.L., 1974, Geology of the South Half of the El Toro Quadrangle, Orange County, California, California Division of Mines and Geology Special Report 110
- Hart, E. W. and Bryant, W.A., 2007, Fault Rupture Hazard Zones in California, Alquist Priolo Earthquake Fault Zoning Act with Index to Earthquake Fault zones Maps, Department of Conservation, Division of Mines and Geology, Special Publication 42, Revised 1997, Interim Revision 2007.
- Jennings, Charles W., 2010, Fault Activity Map of California and Adjacent Areas, Department of Conservation, Division of Mines and Geology, Geologic Data Map No. 6.
- U. S. Geological Survey, 2013a, 2008 Interactive Deaggregations Program; web site address: <https://geohazards.usgs.gov/deaggint/2008/>
- U.S. Geological Survey, 2013b, U.S. Seismic Design Maps, web site address: <http://geohazards.usgs.gov/designmaps/us/application.php>

AERIAL PHOTOGRAPHS REVIEWED

<i>Date</i>	<i>Flight</i>	<i>Photo No.</i>	<i>Scale (1"=)</i>	<i>Source</i>
12/12/1952	3K	73-75	N/A	Continental
3/28/1959	261	139-141	N/A	Continental
8/15/1959	261	21-23	1,000	Continental
9/20/1965	1FF	105, 106	N/A	Continental
3/30/1967	2	132-134	N/A	Continental
1/31/1970	61	166-168	N/A	Continental
10/30/1973	132	9-11	N/A	Continental
1/13/1975	157	253, 254	N/A	Continental
4/21/1977	181	7-9	N/A	Continental
12/13/1978	203	24, 25	N/A	Continental
1/9/1978	F	253, 254	N/A	Continental
2/25/1980	80033	159, 160	N/A	Continental
1/31/1981	211	15-17	2,000	Continental
4/8/1983	218	17-19	N/A	Continental
1/20/1992	C85	7-9	N/A	Continental
2/2/1993	C86	35, 36	N/A	Continental
1/28/1995	C-102	98, 99	2,000	Continental
9/11/1997	C-116	22, 23	2,000'	Continental
3/2/1999	135	154-156	N/A	Continental



Liquefaction

Areas where historic occurrence of liquefaction, or local geological, geotechnical and groundwater conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.



Earthquake-Induced Landslides

Areas where previous occurrence of landslide movement, or local topographic, geological, geotechnical and subsurface water conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.

BASE: DIVISION OF MINES AND GEOLOGY SEISMIC HAZARDS MAP,
EL TORO QUADRANGLE
Dated: Jan. 17, 2001



SEISMIC HAZARDS MAP

Project Number: 16098-01

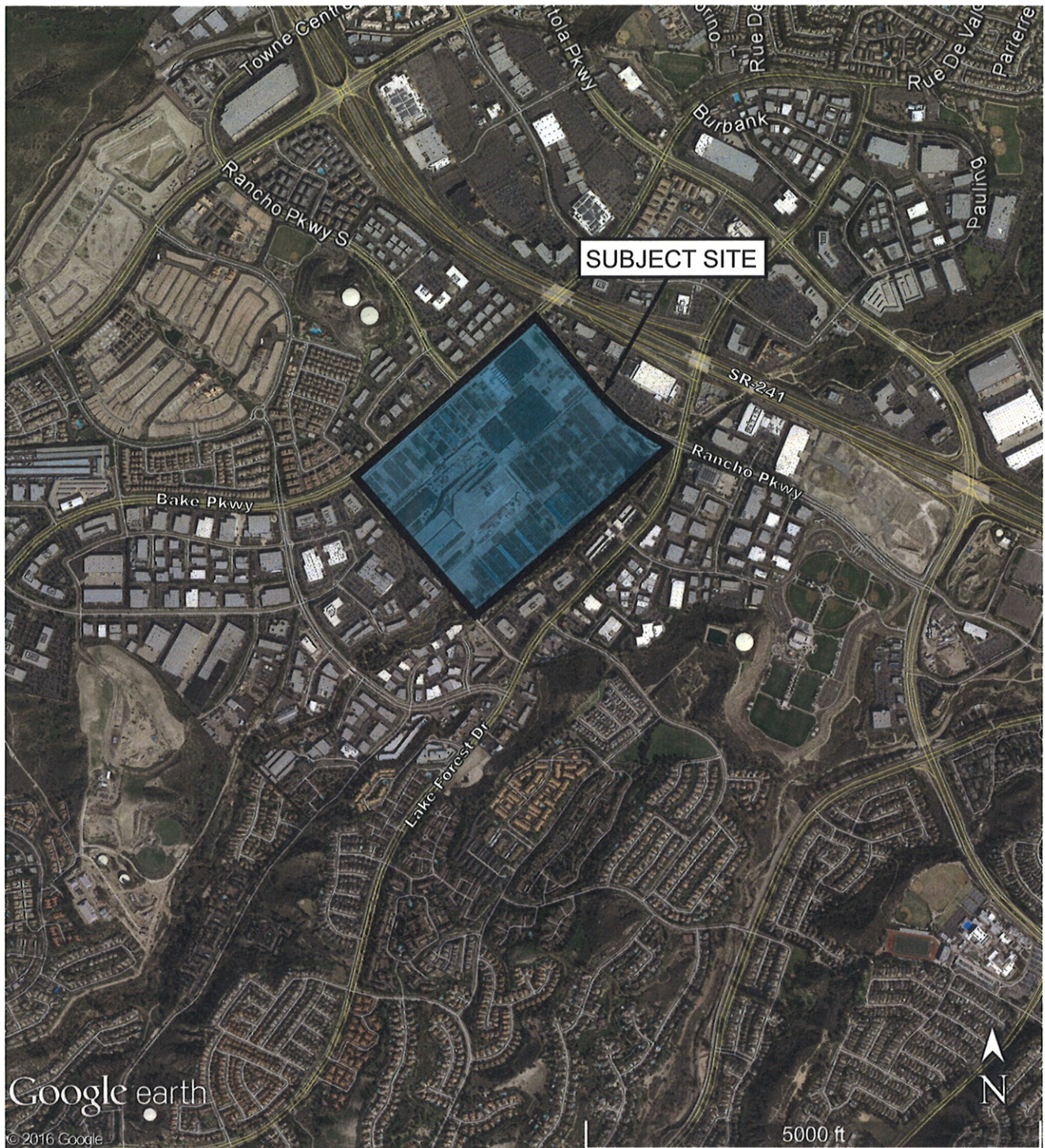
Project Name: Toll Brothers / Lake Forest Nursery

Date: 4/19/17

By: WG

Figure 2

NMG
Geotechnical, Inc.



Base Map: Google Earth, 2016

SITE LOCATION MAP

Project Number: 16098-01

By: WG

Project Name: Toll Brothers / Lake Forest Nursery

Date: 4/19/17

Figure 1

NMG
Geotechnical, Inc.